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GLAUCONITE

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The samples of glauconite were taken from the (Cretaceous) Greensands of New Jersey.¹

William B. Clark states that there are "two conditions necessary in the development of glauconite (1) deposition of particles of land derived origin, and (2) the presence of Foraminifera."

Murray and Renard state:

The chambers become filled with muddy sediment, and if we admit that the organic matter inclosed in the shell and in the mud itself transforms the iron into sulphide, which may be oxidized into hydrate, sulphur being at the same time liberated, this sulphur would become oxidized into sulphuric acid, which would decompose the fine clay, setting free colloid silica and hydrated oxide of iron in a state most suitable for their combination.

Leith says:

It is difficult to see how so high a percentage of iron as is found either in glauconite or greenalite can be derived from the decomposition of mud filtered into the interior of the shell. The contents of metallic iron shown in the analysis of the greenalite rock is 25 per cent. In the typical glauconite deposits foreign material is present outside of the shells, and there seems to be no reason why all this material should not be drawn upon for the supply of iron.²

He further states:

Where iron is being contributed to ocean waters in considerable abundance, it is possible to conceive of minute organisms abstracting the same and depositing it directly in such form as glauconite or greenalite.

The New Jersey glauconite was deposited in comparatively shallow water, as is shown by the land-derived material present even in the purest samples of glauconite, and the cross-bedding.

In the glauconite I have studied, the casts of shells of Foraminifera seem to be the exception rather than the rule. The grains are

¹ See The Atlantic Highlands Section of the New Jersey Cretacic, *American Geologist*, 1905.

² *Monograph 43* of the U. S. Geological Survey: "The Mesabi Iron-Bearing District of Minnesota," pp. 254.

rounded, but, except for one instance, there seems to be no indication that a shell once surrounded them. In one sample the perfect shells of Foraminifera were found among the glauconite grains, which would seem to oppose the idea that the glauconite was first contained in the shells, which were afterward dissolved by the action of sea water.

While glauconite does not have the concentric lines generally seen in the oölites, yet the similarity in shape and structure to grains of oölitic, which do not show the concentric lines, suggests that many of the rounded grains of glauconite are concretions, and formed in a manner similar to that of the oölites. In some grains of glauconite was noted an indication toward concentric lines. The silica, lime, and iron which form the oölites tend to take the concentric structure more readily than does the glauconite.

The New Jersey beds contain glauconite in pockets, masses of glauconite, grains with some cementing clay, or as disseminated grains of glauconite. Where there is much clay present, the conditions are not so favorable for the further concentration of the glauconite as when it is more arenaceous.

The Navesink, a greensand bed from which most of my samples were taken, is composed of grains of glauconite with more or less clay and fragments of the older rocks. It also contains a clay iron stone, concretionary in form, which contains grains of glauconite.

The Redbank sand overlying the Navesink is composed of quartz grains, and contains glauconite which is easily affected by water and oxidizes, and gives the red and yellow colors so prominent in this bed. I have picked out round grains of magnetite with a weak bar magnet from this material which may have been originally grains of glauconite. Limonite is seen filling cracks in the clay bed at the top of the Navesink underneath and replacing fossils.

Pieces of limonite the size of a hand were collected from the Redbank. The slides in which the grains show the greatest alteration are from samples from the Redbank.

Van Hise¹ shows that hematite, limonite, magnetite, greenerite, pyrite, etc., change from one form to the other, so that glauconite altering to one form may be changed into any of the others.

¹ *Monograph 47* of the U. S. Geological Survey, on "Metamorphism."

By putting some glauconite in a test-tube and heating with conc. HNO_3 , and afterward diluting and adding NH_4OH (conc.), an iron test is obtained.

The slides show glauconite grains little altered, in the midst of which is a grain greatly altered. In other slides a few grains are unaltered, while most of the grains are highly altered, indicating two kinds of glauconite, probably deposited at different times. The size of the grains also varies greatly.

Some slides show glauconite altering to limonite; others, glauconite to clay; others, glauconite to hematite; others, glauconite to magnetite; and others, glauconite to hornblende or mica. Glauconite, both solid and fibrous, is found coating grains of quartz, feldspar, mica, pyroxene, etc.

The slides show also clay, quartz, orthoclase, microcline, rutile, and mica. Some slides are almost all clay, with a few grains of glauconite, while others are made up almost entirely of glauconite grains, with the decomposition products filling in the spaces between the grains, and extending from the margins inward toward the center of the grains.

In a slide from a clay ironstone bed in the Navesink are rounded grains of glauconite, grains partly fibrous, rectangular, and broad and irregular oval, so that there is a considerable variation both in the size and in the shape of the glauconite grains.

There is a fibrous kind of glauconite which may, in some instances, be due to the alteration to hornblende, mica, or some allied mineral. In some glauconite grains are rows of small grains of magnetite. All gradations are noted from unaltered glauconite, to glauconite changed to a network of magnetite. In a slide are quartz grains and quartz containing magnetite. Magnetite is seen filling the cracks in glauconite.

In a slide there is a shell of a Foraminifera cut through, which shows the division walls of the shell. The chambers in this shell are filled with what might be called ocean mud filtered in, rather than glauconite, as it differs from the glauconite seen in the same slide both in color and behavior under the crossed nicols, indicating a slightly different mineral composition, as if it (having been inclosed in the shell, and thereby separated from the surrounding material)

lacked some of the chemical components which go to make up the glauconite. The slides were prepared by boiling in Canada balsam to render them hard before grinding down.

In a sample examined from Bed 2, *Gypheæ vesicularis* bed, of the Navesink, the purest sample of glauconite I had, there were five specimens of Foraminifera (Nautiloid type, Trochoid type, Nucularia type, and Nodosaria type), but the shells were still intact, and the shape and size differed considerably from the glauconite grains.

Some glauconite grains are solid, while others have fine lines running across them, as if they had been further divided up. Some grains would seem to indicate by their shape that they had been formed inside a shell, but other evidence of this seems to be lacking.

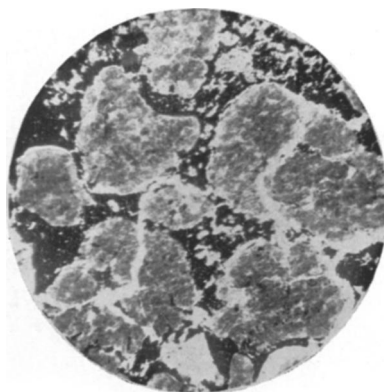
TABULAR LIST OF SLIDES

Bed ¹	Slide	
Nav.....	Ca	Two altered grains of glauconite surrounded by fresh grains
Nav.....	E4	Same as above, but with more alteration
Nav.....	Ca	Glauconite altered to magnetite
Mat.....	p	Contains glauconite, muscovite, microcline, quartz, rutile in quartz, glauconite altered to iron
Mat.....	E5	Same as preceding
Mat.....	typ.	Same as two preceding, but smaller mineral particles
Nav.....	gyp.	Fibrous glauconite, gypsum surrounded by glauconite, and inclosing grains of quartz and glauconite.
Nav.....	B1	Altered and unaltered grains and a clay ground-mass
Nav.....	G3	Much clay, alteration to clay, and also to magnetite
Nav.....	G2	Glauconite unaltered, and partly altered to magnetite.
Nav.....	G1	Abundance of quartz and feldspar, and little glauconite
Nav.....	A1	Alteration chiefly to hematite
Nav.....	24	Grains of microcline and mica coated by glauconite, which is also partly altered to magnetite, masses of pyrite (secondary), fibrous glauconite
Nav.....	8	Glauconite coating mica, rounded, oval, semicircular, and rectangular grains of glauconite, and a cross-section of a Foraminifera mentioned above, grains of quartz, orthoclase, microcline, pyroxene, mica, plagioclase, a quartz grain coated by glauconite which is partly altered to magnetite
Nav.....	22	A large grain of glauconite made up of aggregates which readily separate; also contains mica, quartz, gypsum, glauconite, etc.
Nav.....	25	Microcline coated by glauconite and shattered grains of quartz and feldspar
Nav.....	26	Quartz coated by glauconite, round grains of glauconite with small grains of magnetite regularly arranged, also mica, hornblende, and pyroxene
Haz.....	6	Composed of glauconite grains more or less altered; some grains appear to be concretions, while others look as if they may be sections of Foraminifera
Nav.....	28	A feldspar grain covered by fibrous glauconite
Red.....	13	Alteration to hematite and to limonite

¹ Nav. = Navesink; Mat. = Matawan; Haz. = Hazlet Sand; Red. = Redbank.



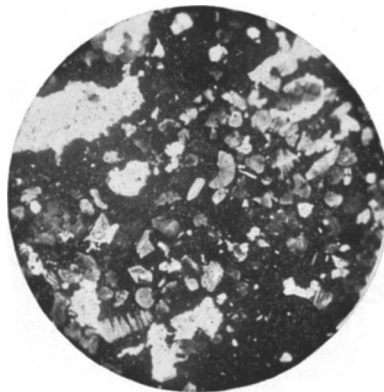
1



2



3



4

Some photo-micrographs are given (by way of illustration) which were taken of some slides of glauconite.

No. 1 is taken from material from a greensand pocket in the Redbank, and is intended to show glauconite grains highly altered.

No. 2 is taken from the clay ironstone of the Navesink, and shows fresh glauconite grains. The dark spaces between the grains show the ground-mass of limonite and clay.

No. 3 is also taken from the clay ironstone of the Navesink, and is to show fibrous glauconite.

No. 4 is taken from a sample of Hazlet Sand from near Cliffwood, N. J. It shows fibrous glauconite, and also the size and shape of some of the glauconite grains.

The diameter of the field of the microscope, when these photo-micrographs were taken, was 2.55^{mm} . In the slide from which No. 2 was taken two grains of glauconite were measured, one of which was 1.3^{mm} long and 0.65^{mm} wide; and the other was round and 0.2^{mm} in diameter. Some grains are smaller than this, down to 0.1^{mm} or less, but they are not so common, and the average grain is much larger than 0.2^{mm} .